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Luebke et al.

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(54) **ENERGY ABSORBENT TABLE**

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(51) **Int. Cl.**

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A47B 13/08	(2006.01)
A47B 13/02	(2006.01)
F16F 7/12	(2006.01)

(52) **U.S. Cl.**

CPC ***A47B 13/081*** (2013.01); ***A47B 13/02*** (2013.01); ***A47B 13/088*** (2013.01); ***A47B 23/04*** (2013.01); ***F16F 7/12*** (2013.01)

(58) **Field of Classification Search**

CPC A47B 13/081; A47B 13/02; A47B 13/088; A47B 23/04; A47B 31/06; A47B 5/04; A47B 5/06; F16F 7/12; B60N 3/001

USPC 108/179

See application file for complete search history.

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(57) **ABSTRACT**

A workstation table having a first panel, a second panel, a support member, and a first deforming mechanism is disclosed. The first deforming mechanism is coupled to the first panel and the support member, and includes a first deformable member. The first panel has a first top surface and a first outer edge, and the second panel has a second top surface and a second outer edge. When a force is applied to a first outer edge, the first deforming mechanism causes deformation of the first permanently deformable member, and causes the first panel to move from a first configuration to a second configuration. In the first configuration, the first top surface and the second top surface occupy substantially parallel planes, and in the second configuration the first top surface and the second top surface do not occupy substantially parallel planes.

35 Claims, 16 Drawing Sheets

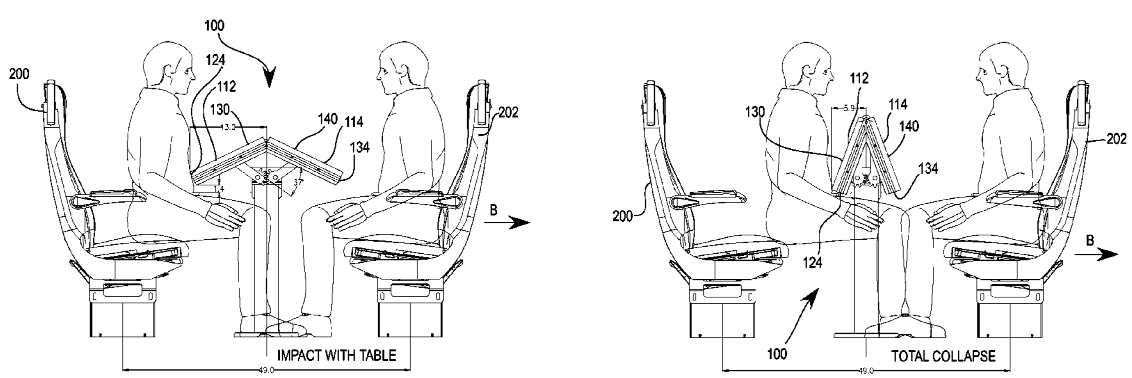

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FIG. 1

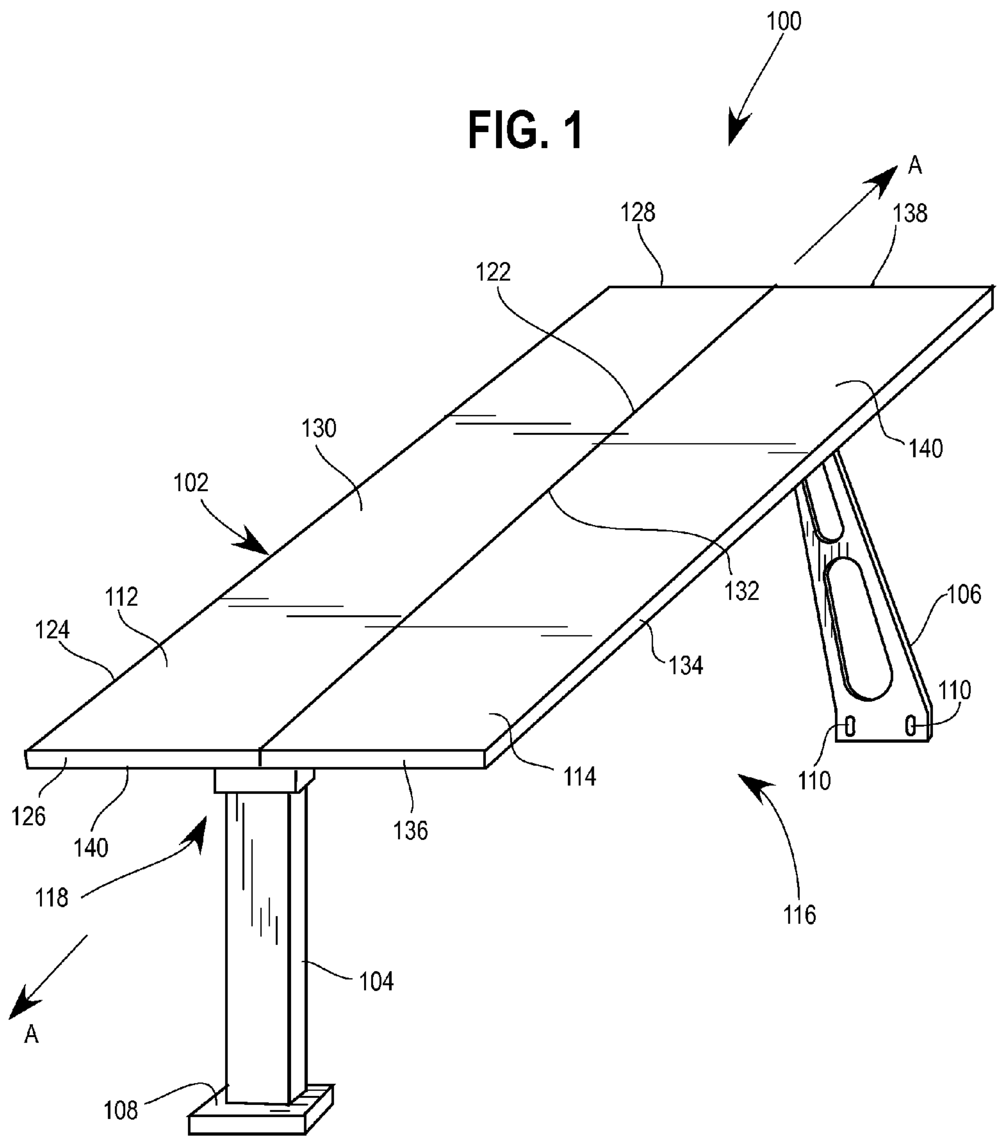
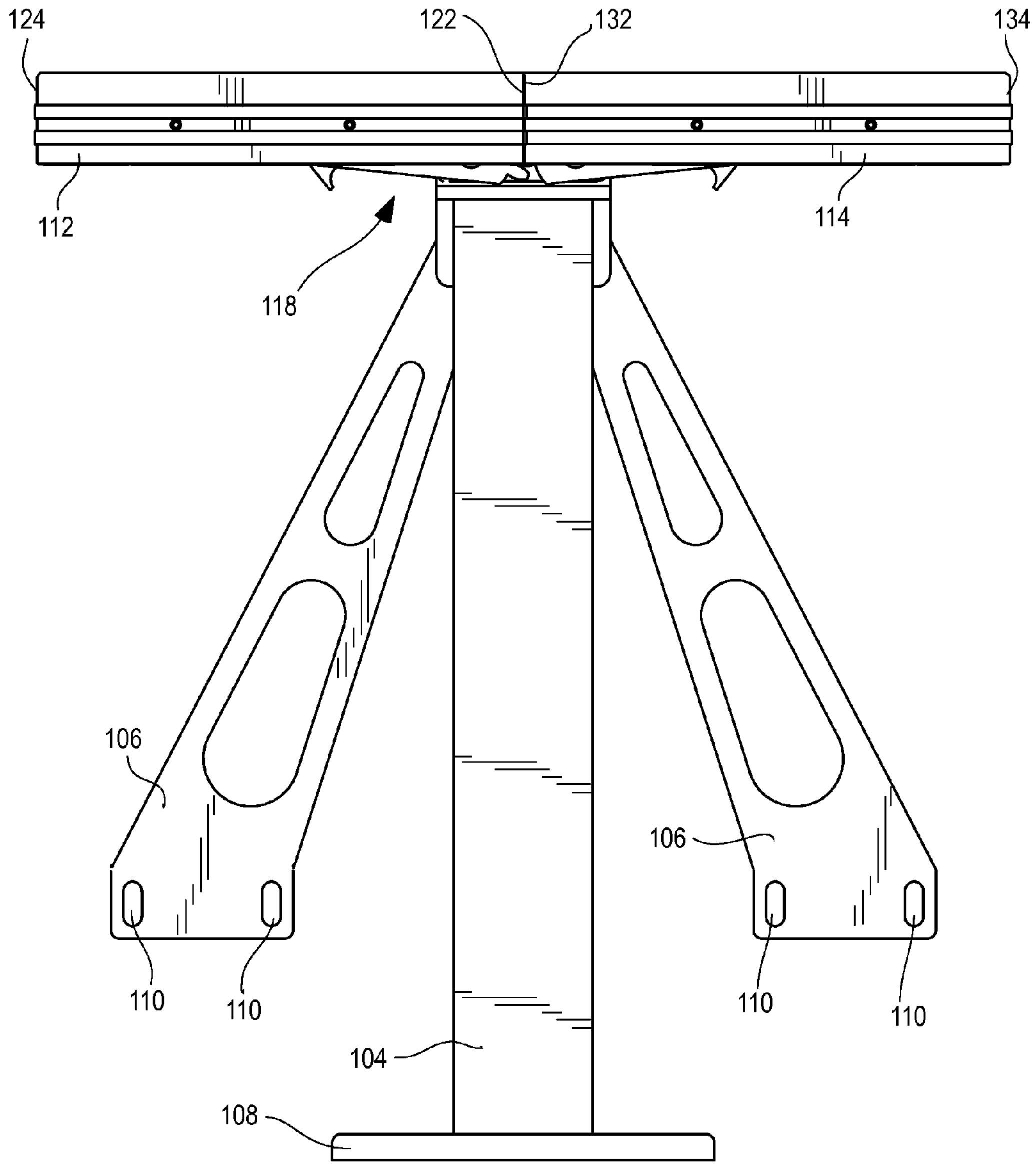

100
A
128
138
122
140
130
102
132
106
112
124
134
110
110
114
126
140
136
118
116
104
A
108

FIG. 2



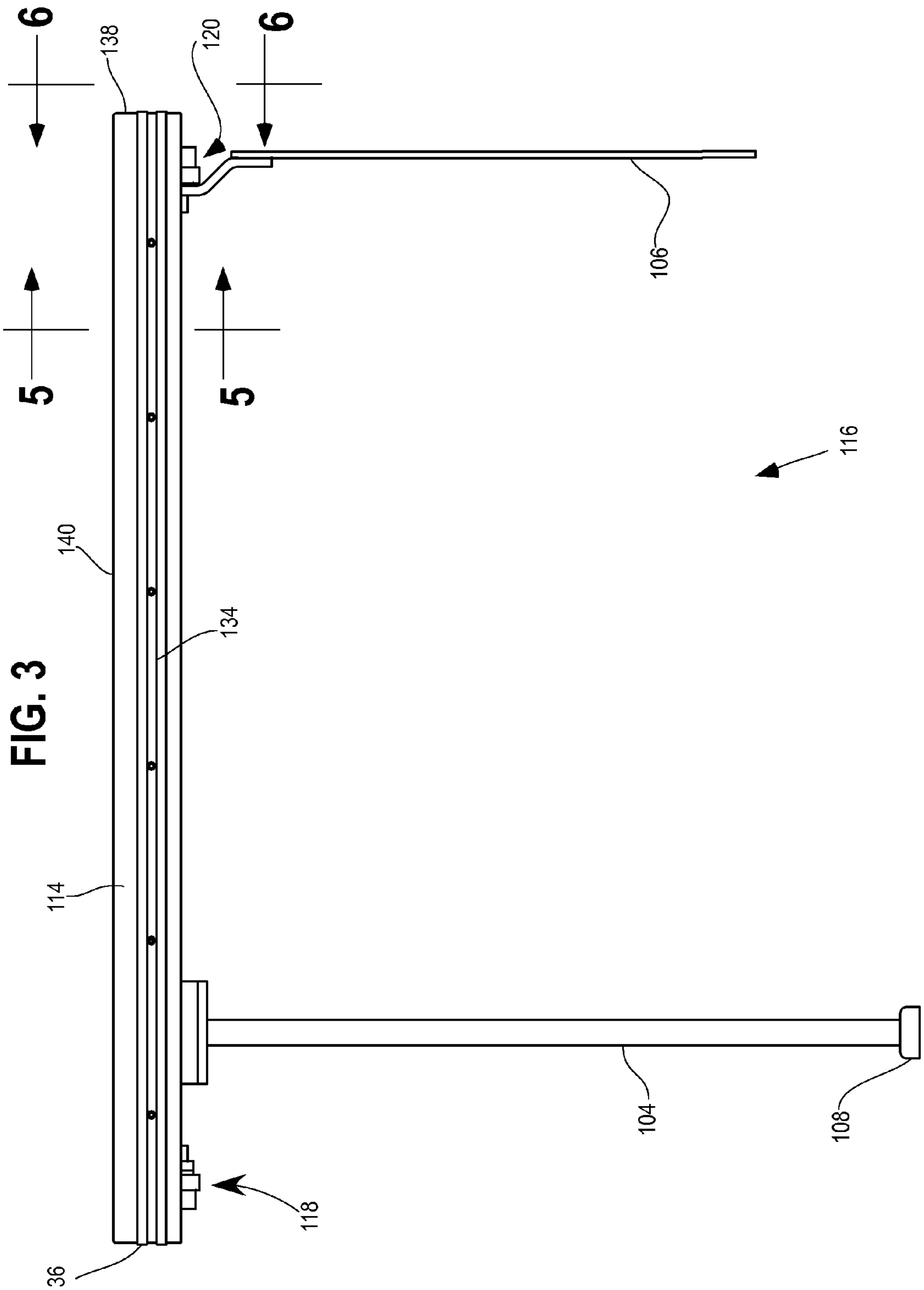


FIG. 3

FIG. 4A

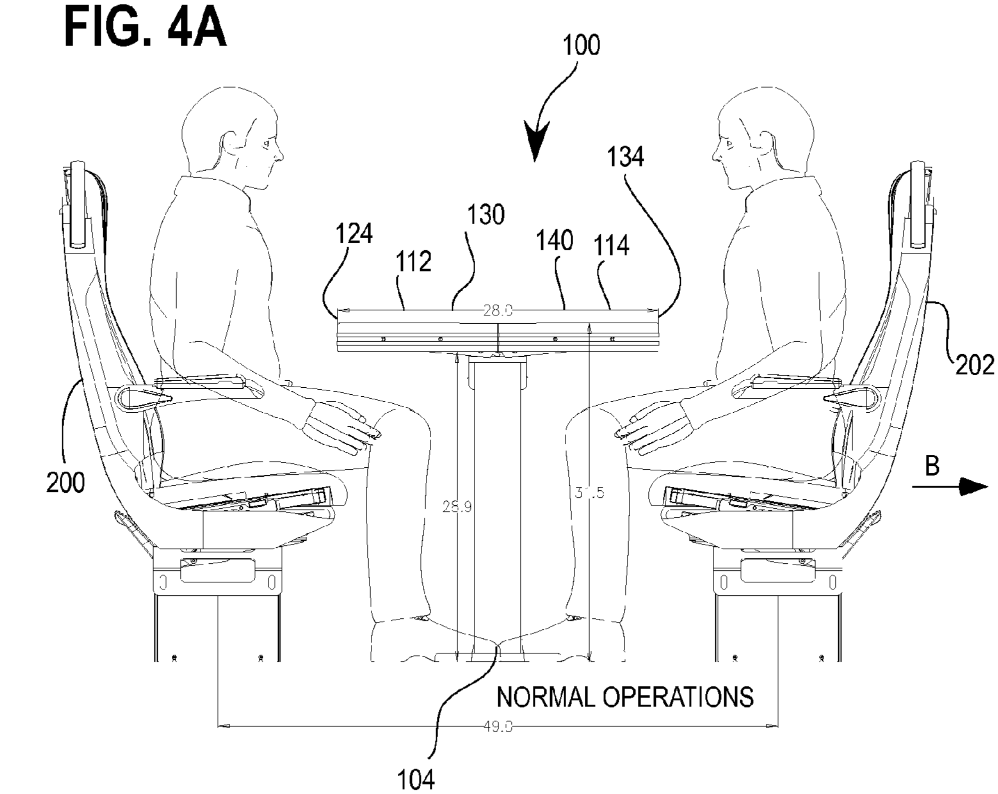

100
134
130
124
112
140
114
28.0
202
200
B
25.9
31.5
NORMAL OPERATIONS
49.0
104

FIG. 4B

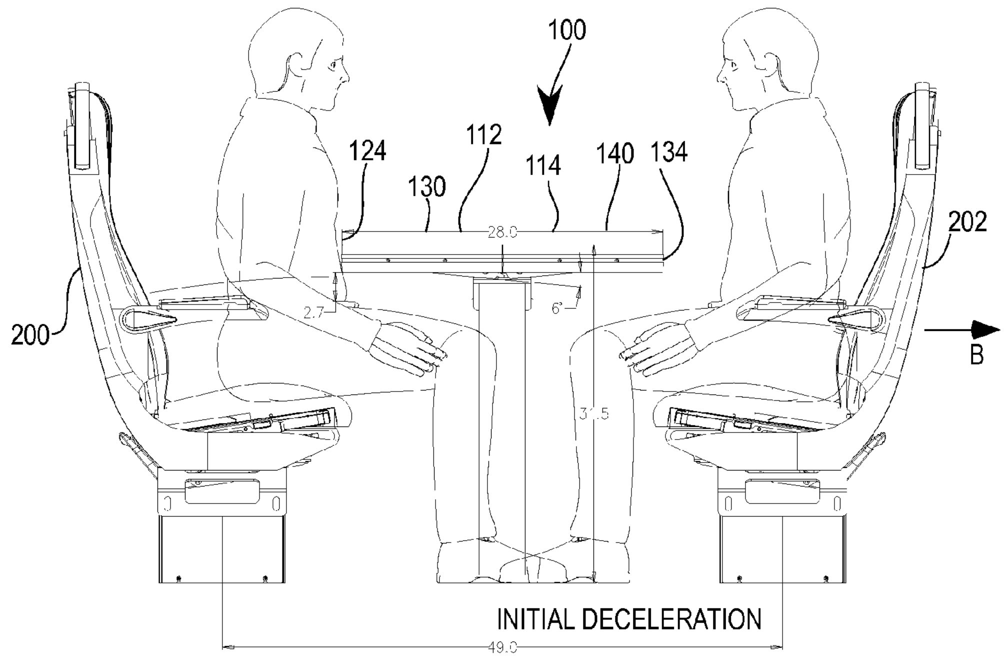

100
124
112
114
140
134
130
28.0
202
200
2.7
6°
B
31.5
INITIAL DECELERATION
49.0

FIG. 4C

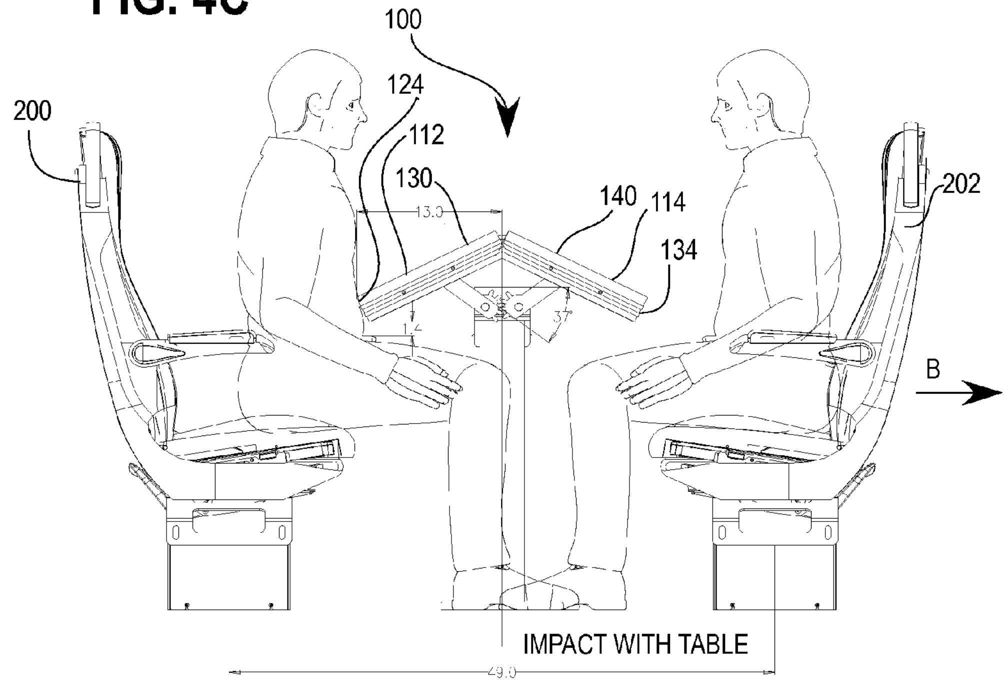

100
124
112
130
13.0
140
114
134
200
202
37°
B
IMPACT WITH TABLE
49.0

FIG. 4D

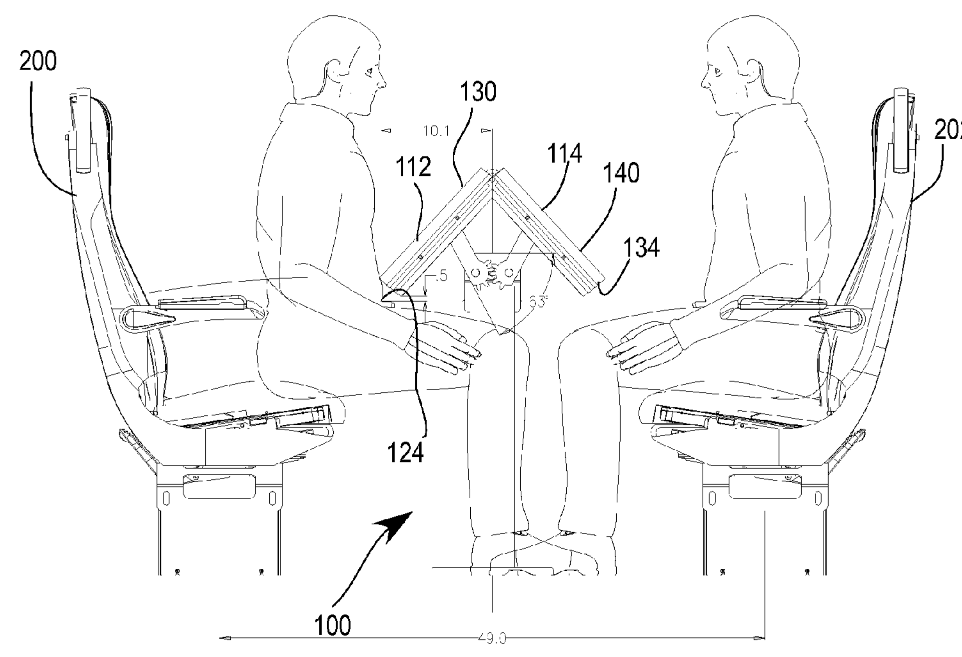

200
130
10.1
114
140
112
134
202
124
100
49.0

FIG. 4E

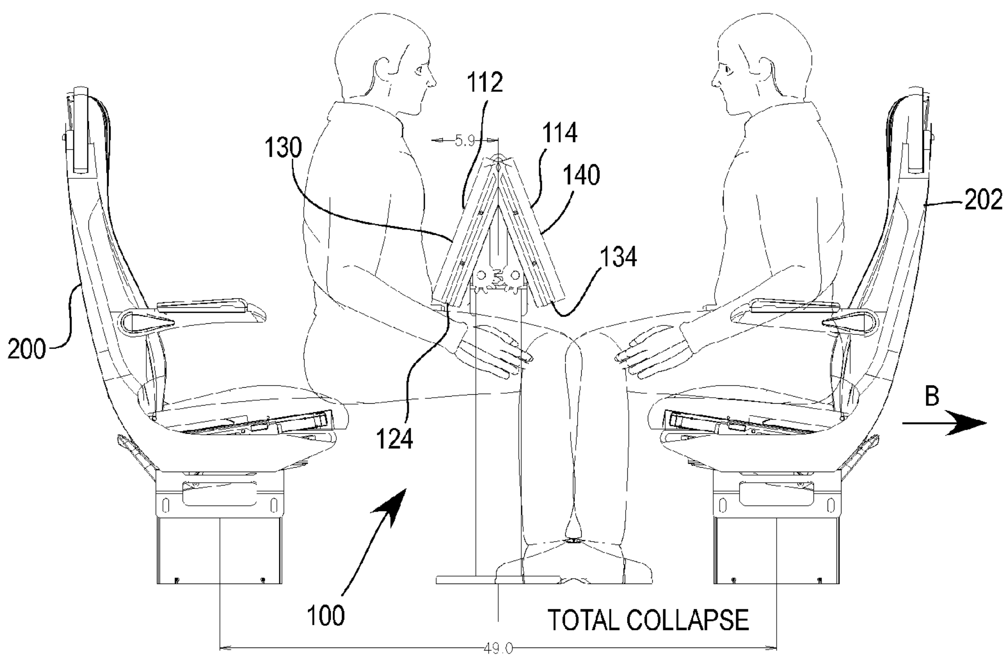


FIG. 5A

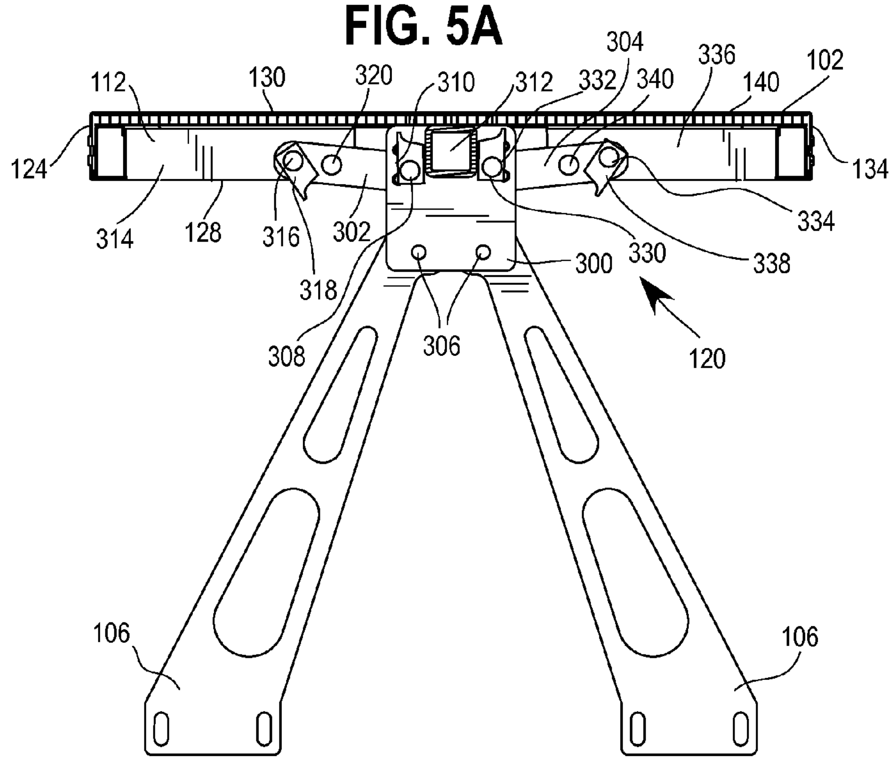

304
336
102
112
130
320
310
312
332
340
140
124
134
334
314
128
316
302
330
338
300
318
308
306
120
106
106

FIG. 5B

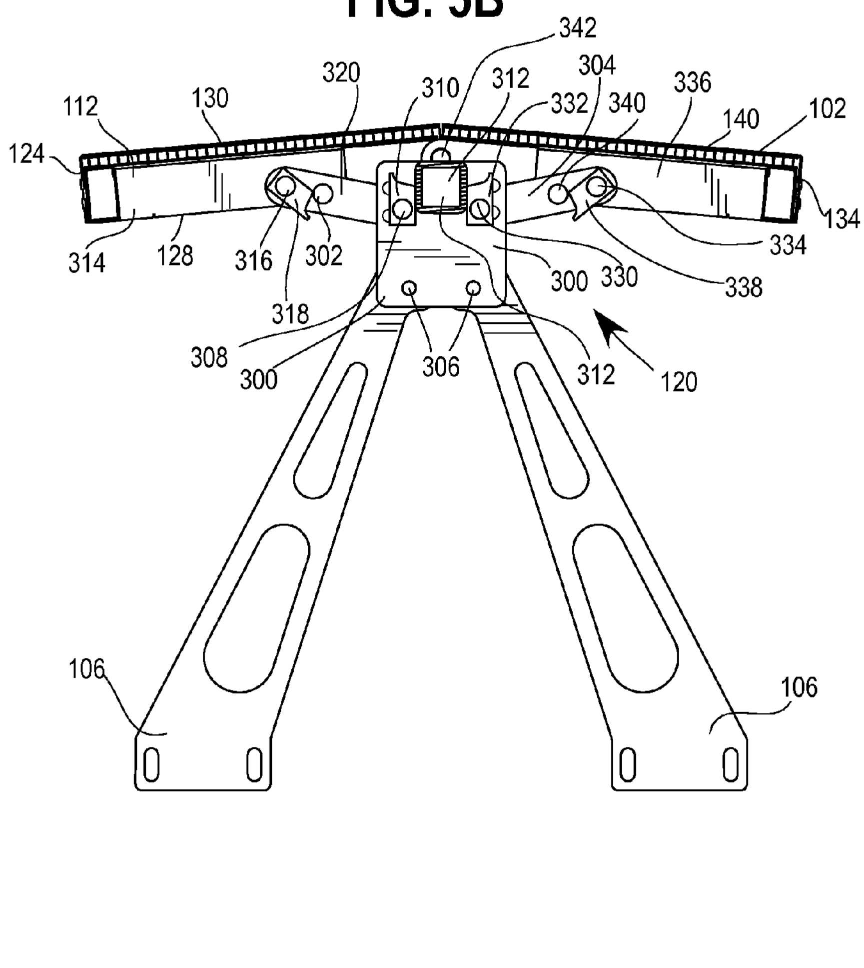

342
320
310
312
304
336
112
130
332
340
140
102
124
134
334
314
128
316
302
300
330
338
318
308
300
306
312
120
106
106

FIG. 5C

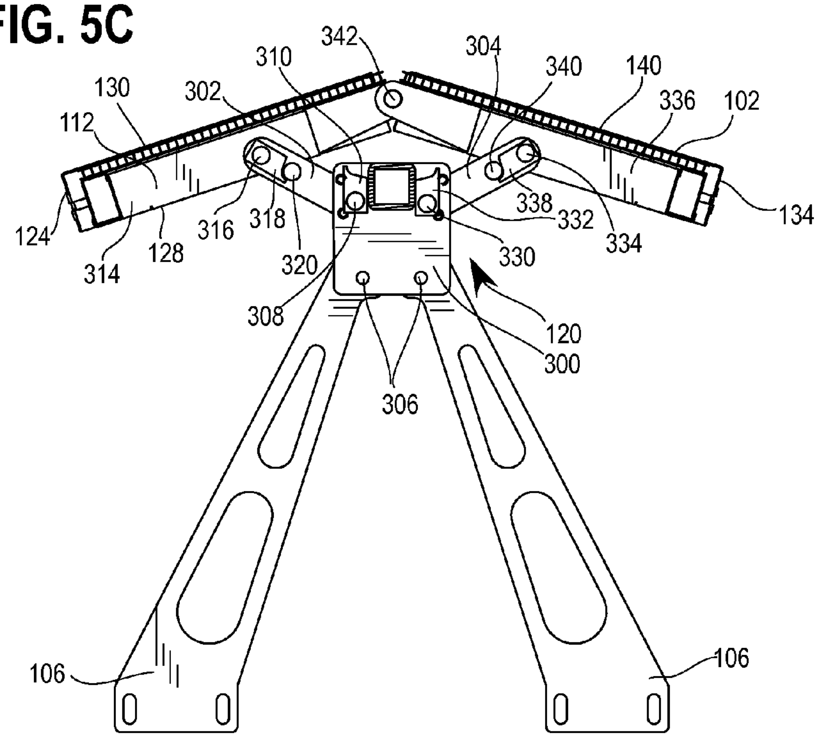
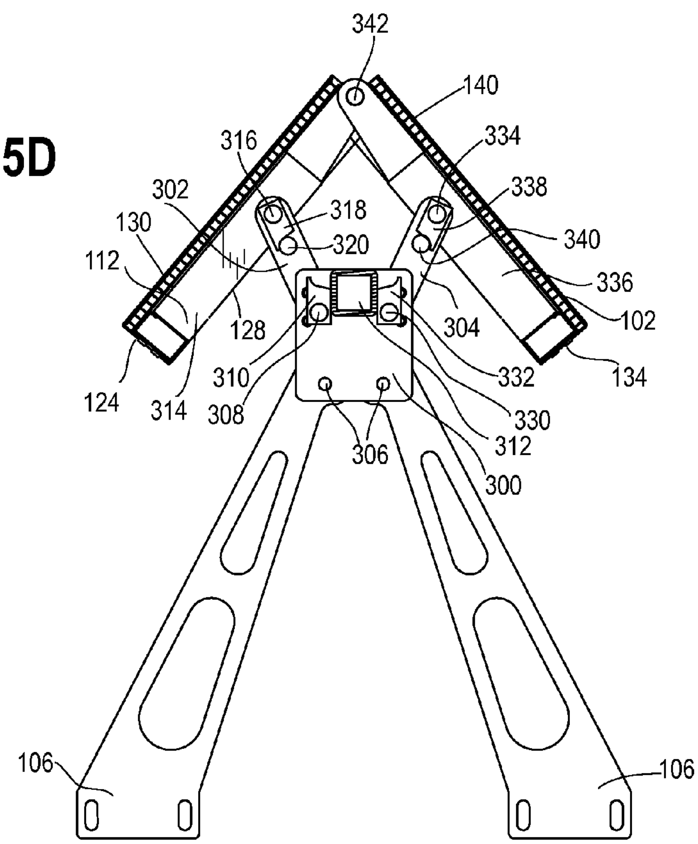

342
304
310
340
140
130
302
336
102
112
124
314
128
316
318
320
338
332
334
134
330
308
120
300
306
106
106

FIG. 5D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140
316
334
302
318
338
130
320
340
112
336
128
304
102
124
314
310
308
332
134
330
312
306
300
106
106

FIG. 6A

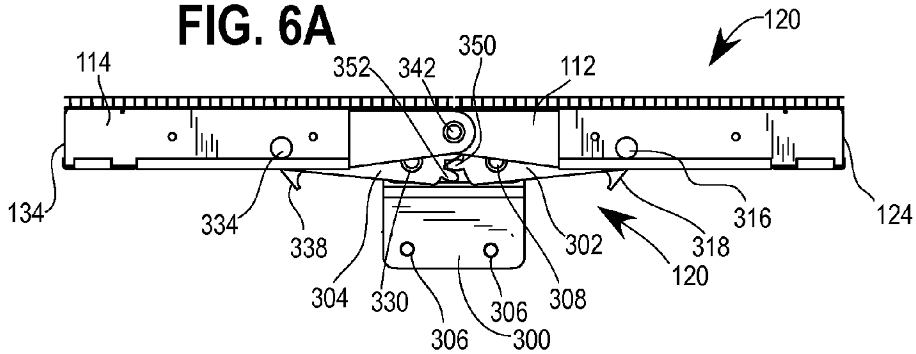


FIG. 6B

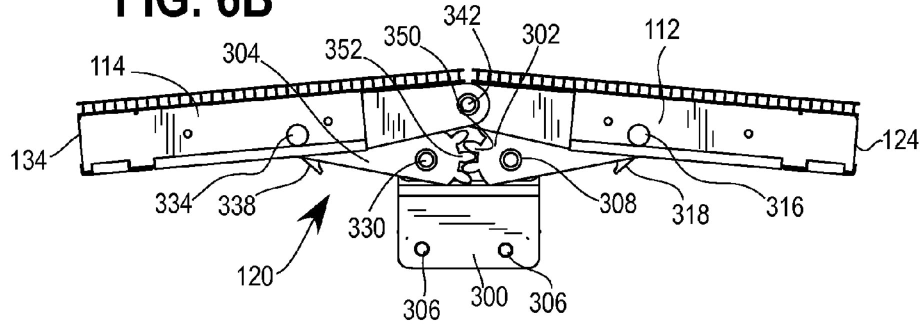


FIG. 6C

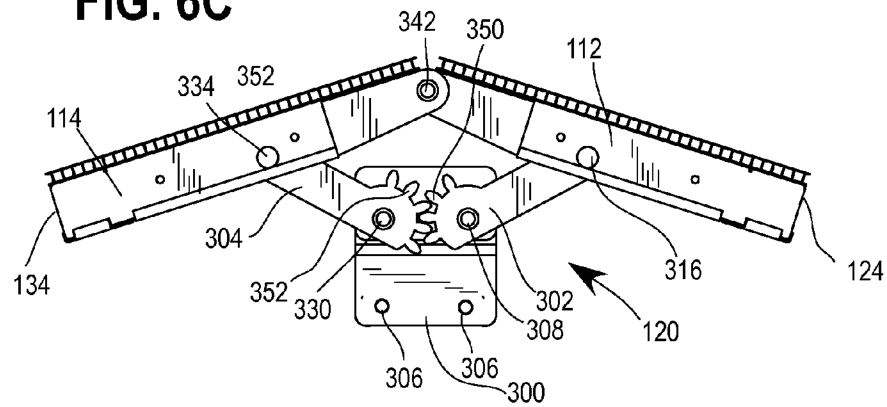
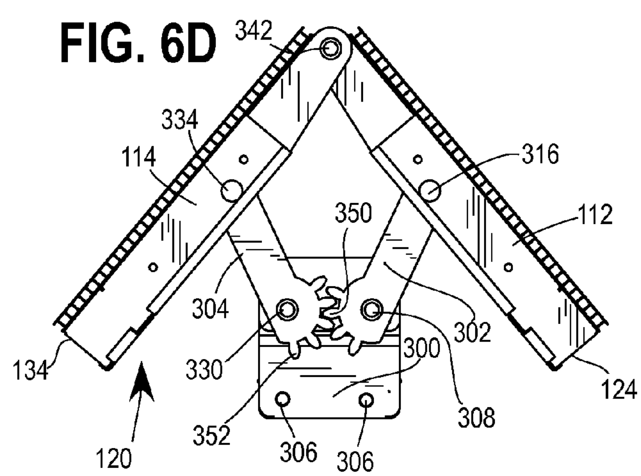


FIG. 6D



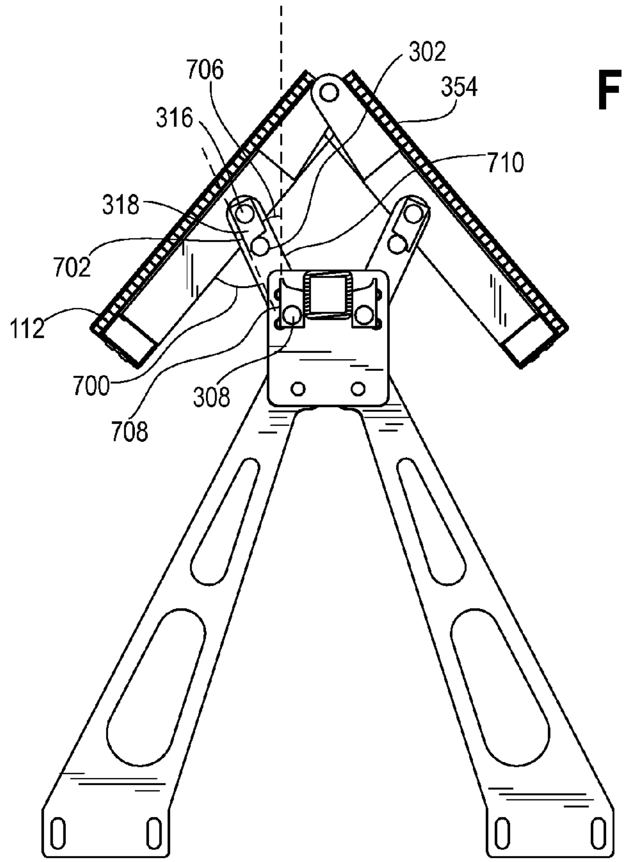

302
706
354
316
710
318
702
112
700
308
708

FIG. 7A

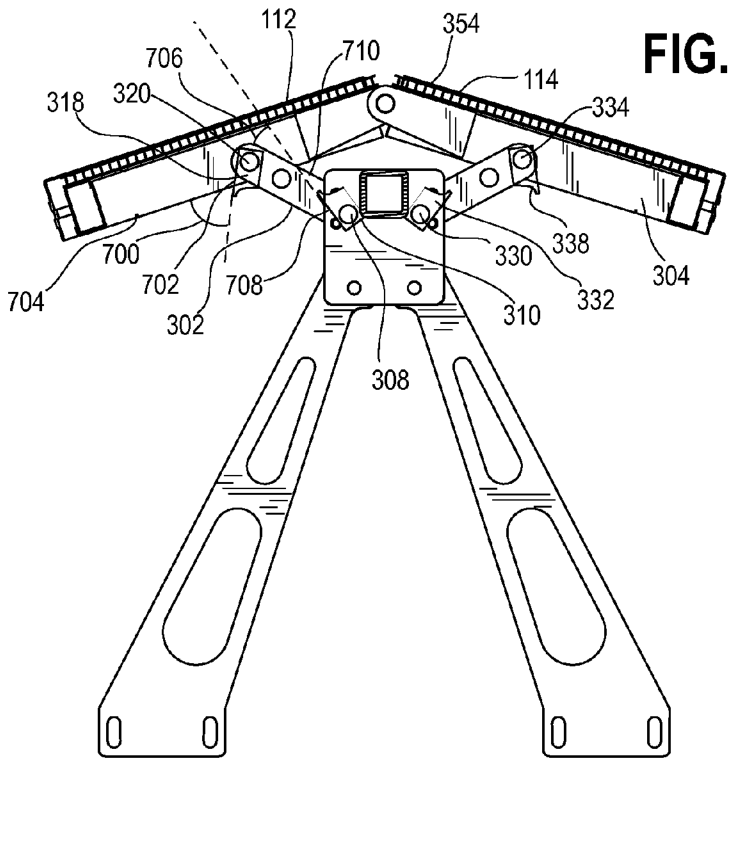

112
354
706
710
114
318
320
334
700
330
338
304
704
702
708
302
310
332
308

FIG. 7B

FIG. 7C

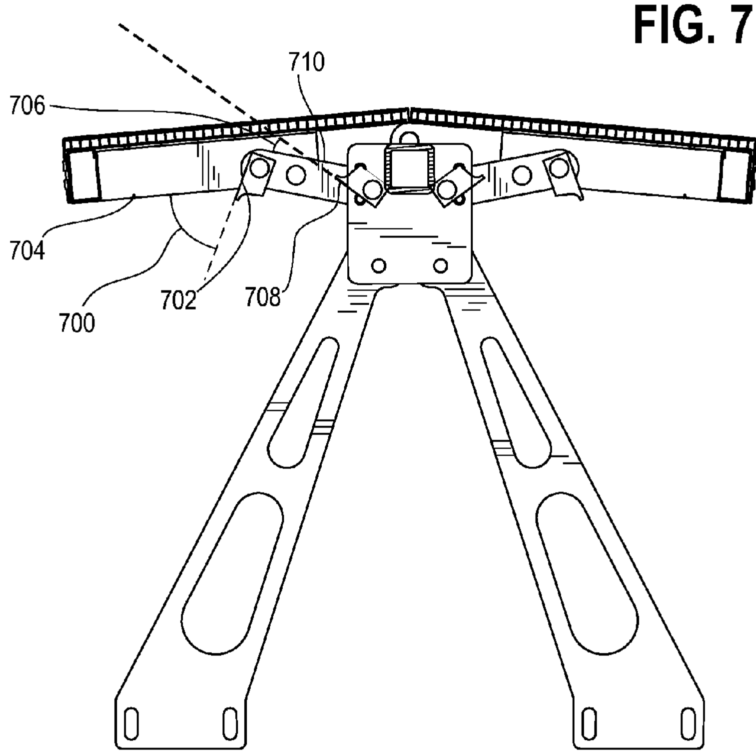


FIG. 7D

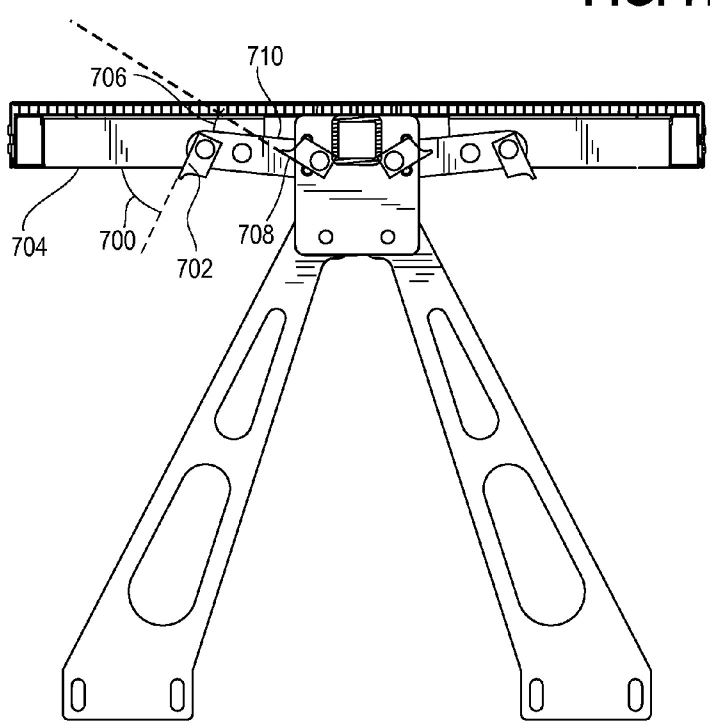


FIG. 8

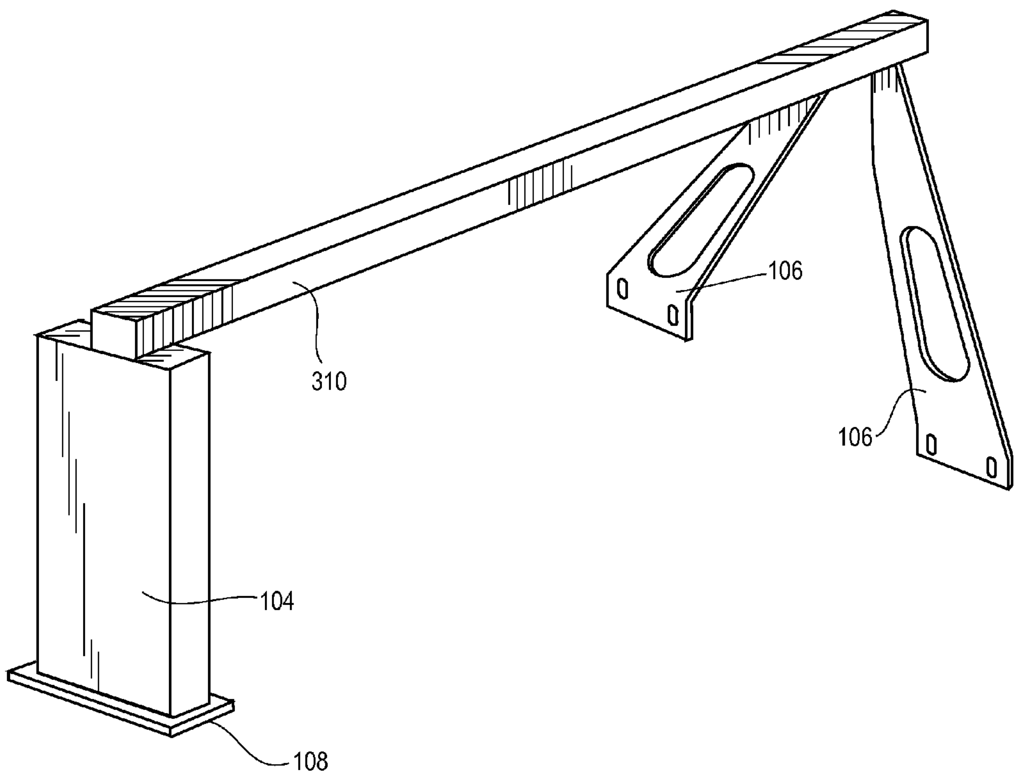


FIG. 9

Force Vs. Edge Displacement

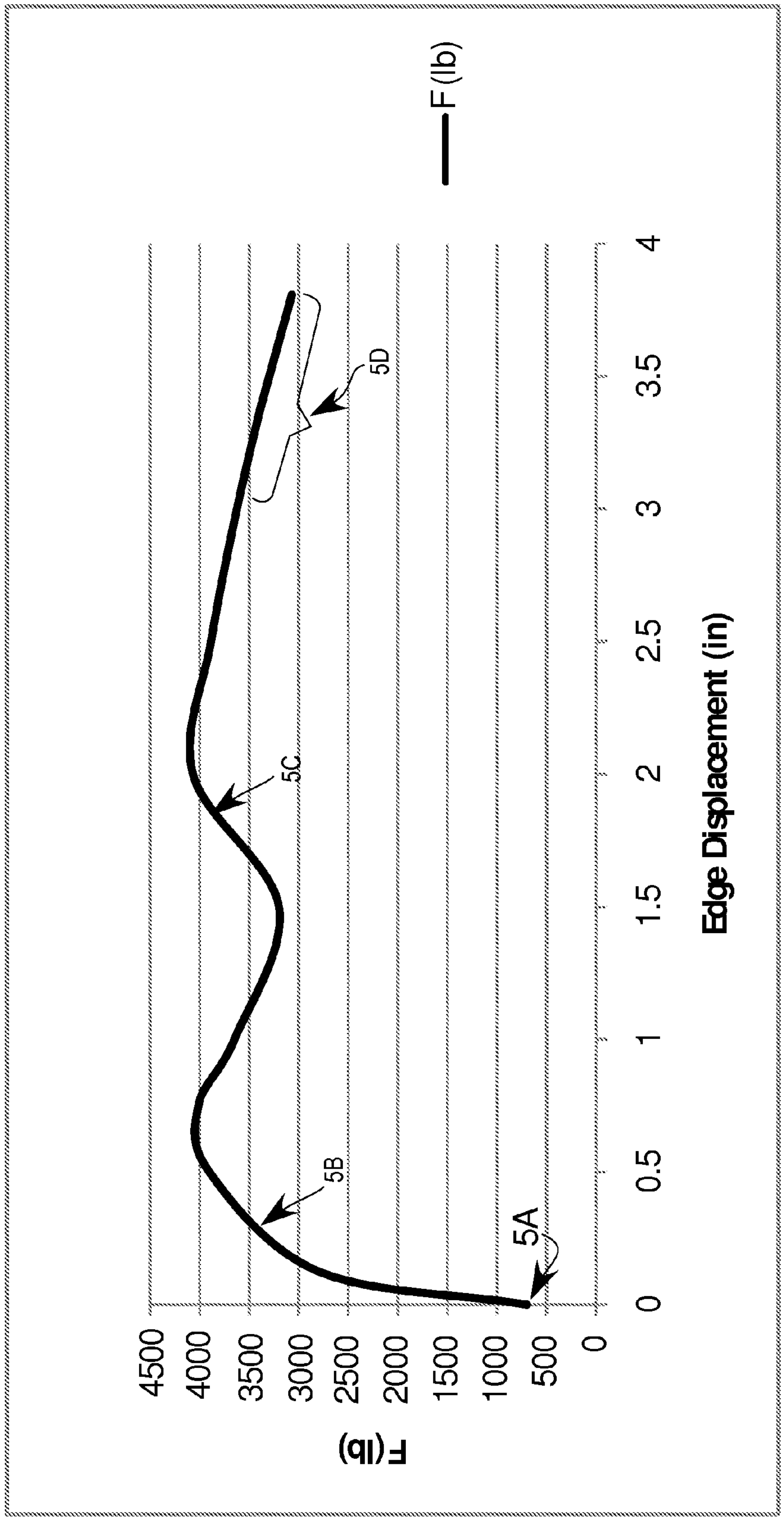


FIG. 10A

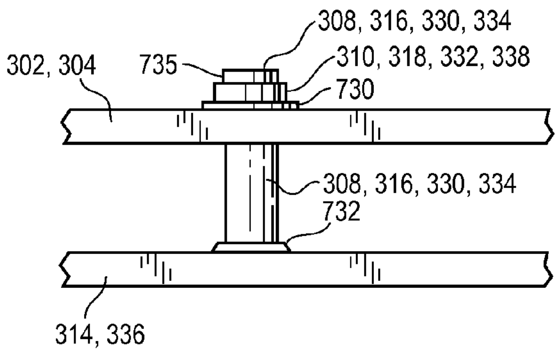


FIG. 10B

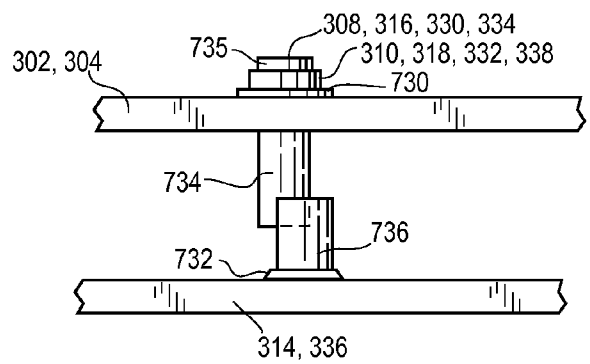


FIG. 10C

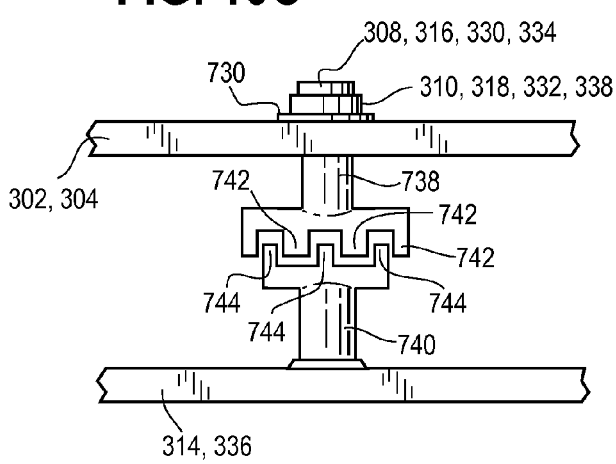


FIG. 11

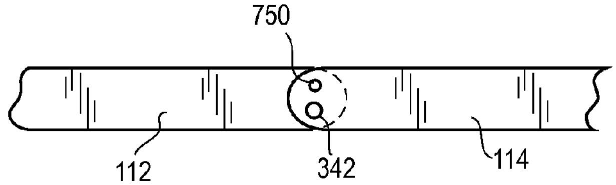


FIG. 12

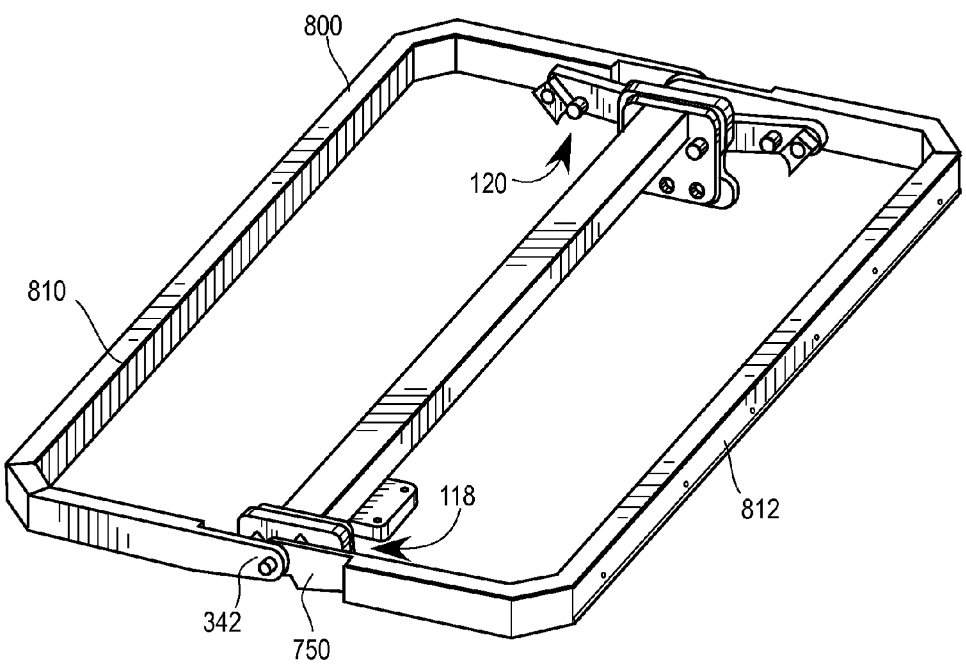
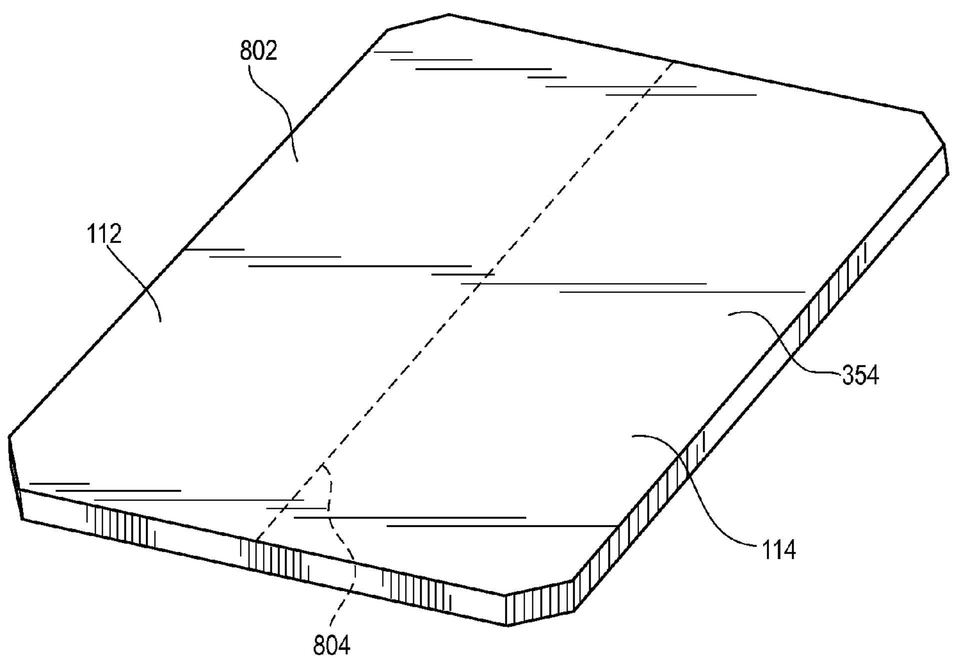


FIG. 13



ENERGY ABSORBENT TABLE

CROSS REFERENCE TO RELATED APPLICATION

The present application claims benefit of Luebke, et al., U.S. Provisional Patent Application Ser. No. 62/016,405, filed on Jun. 24, 2014, and entitled "Collapsible Workstation Table." The entire contents of this application is incorporated herein by reference.

FIELD OF THE DISCLOSURE

The present subject matter relates to a workstation table, and more particularly, to an energy absorbent table.

BACKGROUND OF THE DISCLOSURE

A transit car may include a workstation table disposed between facing seats. If the transit car abruptly decelerates, for example, because of an accident, a passenger in one of the seats facing the direction of the movement of the transit car could suddenly be thrust into the workstation table. The impact of the passenger with a tabletop of the workstation table may seriously injure the passenger.

SUMMARY OF THE DISCLOSURE

According to one aspect, an energy absorbing table that deforms in response to application of energy thereto includes a support member, a first panel, and a first arm. The first arm is coupled to the first support member by a first deformable member and to the first panel by a second deformable member. A first cam and a first stop are associated with the first deformable member. Application of a force to the first panel causes the first arm to move in synchrony with the first deformable member and the second deformable member, and the first deformable member rotates with the first cam until the first cam engages the first stop. Application of force to the first panel after engagement of the first cam and the first stop causes the first panel to move in synchrony with deformation of the first deformable member.

According to another aspect, an energy absorbing table that deforms in response to application of energy thereto includes a support member, a first panel, and an arm coupled to the support member by a first deformable member. The table also includes a first cam and a first stop associated with the first deformable member. When a force is applied to the first panel, the arm moves in synchrony with both the first deformable member and the first cam until the first cam engages the first stop, and in synchrony with deformation of the first deformable member after the first cam engages the first stop. The amount of force necessary to cause the arm to move after the first cam engages the first stop is determined by a characteristic of the first deformable member.

According to a further aspect, a workstation table includes a first panel, a second panel, a support member, and a first deforming mechanism. The first deforming mechanism is coupled to the first panel and the support member, and comprises a first permanently deformable member. The first panel has a first top surface and a first outer edge, and the second panel has a second top surface and a second outer edge. When a force is applied to the first outer edge, the first deforming mechanism causes deformation of the first permanently deformable member, and causes the first panel to move from a first configuration to a second configuration. In the first configuration, the first top surface and the second top surface occupy substantially parallel planes, and in the second configuration the first top surface and the second top surface do not occupy substantially parallel planes.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an isometric view of a workstation table;

FIG. **2** is a front view of the workstation table of FIG. **1**;

FIG. **3** is side view of the workstation table of FIG. **1**;

FIGS. **4**A-**4**E are schematic views that illustrate how a tabletop of the workstation of FIG. **1** may deform;

FIGS. **5**A-**5**D are cross-sectional views taken along the line **5**-**5** of FIG. **3** and illustrate a deforming mechanism of the workstation table of FIG. **1**;

FIGS. **6**A-**6**D are side views taken along the line **6**-**6** of FIG. **3** and further illustrate the deforming mechanism of the workstation table of FIG. **1**;

FIGS. **7**A-**7**D are cross-sectional views taken along the line **5**-**5** of FIG. **3** to illustrate returning the workstation table of FIG. **1** from a deformed configuration to an undeformed configuration;

FIG. **8** is an isometric view of the workstation table of FIG. **1** without the tabletop thereof;

FIG. **9** is a graph that shows force versus edge displacement in an exemplary workstation table of FIG. **1**;

FIGS. **10**A-**10**C are partial planar views of deformable members of the workstation table of FIG. **1**;

FIG. **11** is a partial planar view of the workstation table of FIG. **1** to illustrate coupling of portions of the workstation table;

FIG. **12** is an isometric view of a frame that comprises a tabletop of the workstation table of FIG. **1**; and

FIG. **13** is an isometric view of a top member that comprises the tabletop of the workstation table of FIG. **1**.

DETAILED DESCRIPTION

Referring to FIGS. **1**-**3**, a workstation table **100** comprises a tabletop **102** disposed on a front support **104** and a rear support **106**. The workstation table **100** may be disposed in a vehicle, for example, a transit car, a rail car, a tram, a bus, an airplane, and the like. If the transit car has an aisle, the front support **104** may be proximate the aisle of the vehicles. In some embodiments, a bottom portion **108** of the front support **104** may be secured to a floor (not shown) of the transit car. In addition, the workstation table **100** may be disposed in the transit car so that the rear support **106** may be secured to a sidewall (not shown) of the transit car. In some embodiments, securing bolts may be passed through openings **110** to affix the workstation table **100** to the sidewall. Similarly, in some embodiments bolts or other securing devices may be passed through openings (not shown) in the bottom portion **108** to secure the workstation table **100** to the floor.

The tabletop **102** may comprise a first side portion or panel **112** and a second side portion or panel **114**. The front support **104** may be disposed between the first panel **112** and the second panel **114**. In some embodiments, the front support **104** may be aligned with a centerline A-A between the first panel **112** and the second panel **114**. In some cases, the tabletop **102**, the front support **104**, and the rear support **106** may be disposed to create a space **116** under the tabletop **102**. Such space **116** provides legroom for individuals seated at the workstation table **100**. In some embodiments, the first panel **112** and the second panel **114** are separate members of the tabletop **102**. In other embodiments, the first panel **112** and the second panel **114** are an integral unit, and are, for example, portions of a contiguous sheet of material that comprises the tabletop **102**.

Each side panel **112** and **114** may be coupled to a first deforming mechanism **118** and a second deforming mechanism **120**, which are described below. The first panel **112** may include an inside edge **122**, an outside edge **124**, a front edge **126**, a rear edge **128**, and a top surface **130**. The inside edge **122** and the outside edge **124** may be substantially parallel and opposite one another, and the front edge **126** and the rear edge **128** may be substantially parallel and opposite one another.

Similarly, the side panel **114** may include an inside edge **132**, an outside edge **134**, a front edge **136**, a rear edge **138**, and a top surface **140**. The inside edge **132** and the outside edge **134** may be substantially parallel and opposite one another, and the front edge **136** and the rear edge **138** may be substantially parallel and opposite one another.

In some embodiments, the inside edge **122** of the first panel **112** may abut or be proximate the inside edge **132** of the second side panel **114** along the centerline A-A. Further, in some embodiments, when the tabletop **102** is in an undeformed configuration (as shown in FIG. **1**), the plane of the top surface **130** of the first panel **112** may be substantially parallel to the plane of the top surface **140** of the second panel **114**. In some embodiments, when the table is in the undeformed configuration, one or both of the planes of the top surface **130** and the top surface **140** may be substantially parallel to the plane of the floor to which the bottom portion **108** of the front support **104** is secured. In some embodiments, the top surface **130** and the top surface **140** may be substantially coplanar. Further, in some embodiments, the front edges **126** and **136** may be substantially collinear and/or the rear edges **128** and **138** may be substantially collinear.

Referring to FIG. **4**A, in one embodiment, the workstation table **100** may be disposed between facing seats **200** and **202**. The seats **200** and **202** may be individual seats or bench seats. A plurality of seats **200** may be disposed on one side of the workstation table **100**, and a plurality of seats **202** may be disposed on the other side of the workstation table **100**. Each of the seats **200** and **202** may include any type of seating apparatus that allows one or more individuals to sit thereon.

Because the front support **104** may be disposed along the centerline A-A of the workstation table **100**, sufficient clearance may be provided between the front support **104** and the seats **200** and **202** for passengers to enter and exit the space between the workstation table **100** and such seats **200** and **202**.

Referring to FIGS. **4**B-**4**E, if the workstation table **100** is disposed in a transit car that is moving in a direction B, and the transit car experiences sudden deceleration, the momentum of the passenger seated in the seat **200** may cause the passenger to continue to move in the direction B at a speed greater than that of the transit car and workstation table **100**. If the deceleration is significant, the passenger's body may not decelerate sufficiently in time to avoid contact with the outside edge **124** of the first panel **112** of the workstation table **100**, as shown in FIG. **4**B. If the passenger's body continues to move in the direction B faster than the transit car, even after such contact, the force of the passenger's body against the outside edge **124**, and hence, the first panel **112**, causes the tabletop **100** to deform (or collapse or buckle). In particular, as is described below, the deforming mechanisms **118** and **120** cause the first panel **112** and the second panel **114** to move from a configuration in which the top surfaces **130** and **140** thereof, respectively, occupy parallel planes or are coplanar, and into a configuration in which such top surface **130** and **140** no longer occupy parallel planes and are not coplanar. In some embodiments, when the tabletop **100** is in a deformed configuration, the angle between the plane occupied by the top surface **130** of the first panel **112** and the plane occupied by the top surface **140** of the second panel **114** is acute. In some embodiments, the acute internal angle between such planes may be approximately 39 degrees. In some embodiments, such acute internal angle may be between approximately 35 and 43 degrees.

When the passenger impacts an outside edge **124** or **134** of the tabletop **102**, energy is transferred from the passenger to cause first and second deforming mechanisms **118** and **120** to operate, and move the first panel **112** and the second panel **114** to deform the tabletop **102**. Such transfer of energy may also cause the passenger to decelerate and reduce the possibility of further impact between the passenger and the table, and thus reduce the risk of injury to the passenger from such impact. Even when the tabletop **102** deforms (as shown in FIGS. **4**B-**4**E), the front support **104** and/or the rear support **106** may continue to secure the workstation table **100** to the sidewall and/or the floor, respectively, of the transit car. In some embodiments, the front support **104** and/or the rear support **106** may also deform as the tabletop **102** deforms, yet continue to secure the workstation table **100** to the sidewall and/or the floor respectively.

Although FIGS. **4**B-**4**E illustrate deformation of the tabletop **102** when a transit car moving in the direction B decelerates, one of skill in the art would appreciate that if a transit car moving in a direction opposite to the direction B were to suddenly decelerate, a passenger in the seat **202** would be urged into the workstation table **100**, and cause the tabletop **102** to deform as described above.

Referring to FIGS. **5**A-**5**D and FIGS. **6**A-**6**D, the deforming mechanism **120** may comprise a plate **300**, a first arm **302**, and a second arm **304**. The plate **300** may be secured to the rear support **106** by one or more bolts **306**. Other forms of mechanical fastening apparent to those who have skill in the art may be used instead of the bolts **306** to secure the plate **300** with the rear support **106**. A first end of the first arm **302** may be pivotally secured to the plate **300** by a deformable member (e.g., a torsion bar, torsion spring, torsion pin, and the like) **308**. A cam **310** may be fixedly secured to the torsion bar **308** such that the cam **310** rotates in synchrony with the torsion bar **308**. A stop **312** may be fixedly secured to the plate **300** and positioned so that the cam **310** engages the stop **312** after a predetermined amount of rotation of the cam **310**, and therefore, the torsion bar **308** (as shown in FIGS. **5**B and **6**B). As the cam **310** and the torsion bar **308** rotate, the first arm **302** moves in synchrony with such rotation.

A second end of the first arm **302** opposite the first end may be pivotally secured to the rear edge **128** of the first panel **112** by a deformable member (e.g., a torsion bar or pin) **316**. A cam **318** may be fixedly secured to the torsion bar **316** such that the cam **318** rotates in synchrony with the torsion bar **316**. A stop **320** may be secured to the first arm **302** and positioned to engage with the cam **318** after the cam **318** has rotated a predetermined amount (as shown in FIGS. **5**C and **6**C). The first arm **302** also moves in synchrony with the rotation of the cam **318** and torsion bar **316**. Further, the movement of the first arm **302** causes movement of the first panel **112** coupled thereto.

A deformable member (e.g., a torsion bar or pin) **330** may pivotally secure a first end of the second arm **304** to the plate **300**. A cam **332** may be fixedly secured to the torsion bar **330** so that the cam **332** rotates in synchrony with the torsion bar **330**. The position and size of the stop **312** may be selected so that such stop also engages the cam **332** after a predetermined amount of rotation of the cam **332** (as shown in FIGS. **5**B and **6**B). For example, in one embodiment, the stop **312** may be positioned such that the center of the stop **312** is equidistant from the axes of rotation of the torsion bars **308** and **330**.

A deformable member (e.g., a torsion bar, spring or pin) **334** may pivotally secure a second end of the second arm **304** to an inside surface **336** of the rear edge **138** of the second panel **114**. A cam **338** may be fixedly secured to the torsion bar **334** so that such cam **338** rotates in synchrony with the torsion bar **334**. A stop **340** may be fixed to the second arm **304** and positioned so that the cam **338** engages the stop **340** after a predetermined amount of rotation of the cam **338** (as shown in FIGS. **5**C and **6**C). The second arm **304** moves in synchrony with the rotation of the cams **332** and **338**, and the rotation of torsion bars **330** and **334**, respectively, coupled to these cams.

If the force continues to be applied to the outside edge **124** or **134** after one or both of the cams **310** and **332** have engaged the stop **312**, the torsion bars **308** and **330** secured to the cams **310** and **332**, respectively, may deform and continue to rotate. Similarly, if force continues to be applied to the outside edge **124** or **134** after one or both of the cams **318** and **338** have engaged the stops **320** and **340**, respectively, the torsion bars **316** and **334** secured to the cams **318** and **338**, respectively, may also deform and continue to rotate. Such deformation of the torsion bars **308**, **316**, **330**, and **334** may cause the arms **302** and **304** to move in synchrony with such deformation, and thereby cause the table **100** to continue to deform as shown in FIGS. **5**A-**5**D even after the cams **310**, **318**, **332**, and **338** have stopped rotating. Further, such deformation of the torsion bars **308**, **316**, **330**, and **334** absorbs additional energy from the impact of the passenger with the outside edge **124** or **134** after the cams **310**, **318**, **332**, and **338** have stopped rotating. These torsion bars **308**, **316**, **330**, and **334** continue to rotate until the passenger has decelerated sufficiently so that the force applied by the passenger to the outside edge **124** or **134** is insufficient to further deform the torsion bars **308**, **315**, **330**, and/or **334**, or the table **100** has reached a predetermined maximum deformation.

In some embodiments, all of the torsion bars **308**, **316**, **330**, and/or **334** may rotate concurrently, and may also begin to deform concurrently. In some cases the torsion bars **308** and **330** may begin to deform (because the cams **310** and **332** engage the stop **312**) before the torsion bars **316** and **334** begin to deform. In some embodiments, the torsion bars **316** and **334** may begin to deform (because the cams **318** and **338** engage the stops **320** and **340**, respectively) before the torsion bars **308** and **330** begin to deform. It should be apparent to one who has skill in the art that adjusting the amount of rotation the cams **310**, **318**, **332**, and **338** may undertake before engaging with the stop associated with such cams may select when a particular torsion bar **308**, **316**, **330**, or **334** begins to deform relative to the other torsion bars **308**, **316**, **330**, and **334**.

The deformable members **308**, **316**, **330**, and **334** may be torsion bars or pins. Other types of deformable members may be selectively employed.

For example, referring to FIG. **10**A, in one embodiment, the deformable member **308** may be a cylindrical post or a rectangular prism that includes an outer portion **735** that is secured to the cam **310**. The deformable member is passed through the arm **302**, and secured to the edge **314** of the workstation table **100**. In some embodiments, a welding joint **730** may affix the cam **310** to the arm **302**, and a welding joint **732** may affix the deformable member **308** to the edge **314**. When force is applied to the outside edge **124** or **134**, the cam **310** and the deformable member **308** begin to rotate about an axis of the deformable member **308**. Such rotation causes the arm **302** to which the cam **310** is secured, and the first panel **112** of the workstation table **100**, to also rotate or move in synchrony with the cam **310** of the deformable member **308**. After, the cam **310** engages the stop **312**, if additional force is applied to the edge **124** or **134**, such force causes the deformable member **308** to deform and continue to rotate, and therefore cause further rotation of the arm **302** and the first panel **112** of the table **100** in synchrony with such deformation. In one embodiment, the deformable member **316** may be affixed to the outer edge **314** and the cam **318**, and arm **302** may be disposed between the cam **318** and the outer edge **314**. Similarly, the deformable member **334** may be affixed to the outer edge **336** and the cam **338**, and the arm **304** may be disposed between the cam **338** and the outer edge **336**. In some cases, the deformable member **308** may be affixed to the cam **310** and the arm **302**, and the deformable member **330** may be affixed to the cam **332** and the arm **304**.

Referring to FIG. **10**B, in some embodiments, the deformable member **308** may include a first plate or beam **734** secured to the outer portion **735**. The outer portion **735** may secured to the cam **310**, and the welding joint **730** secures the cam **310** to the arm **302**. The deformable member **308** also includes a second plate or beam **736** secured to and cantilevered from the arm **314**. The first plate **734** is disposed relative to the second plate **736** such that the plate **734** contacts the second plate **736** when the cam **310** engages the stop **312**. When force is applied to the outside edge **124**, the cam **310** and plate **734** rotate until the cam **310** engages the stop **312**. Thereafter, if additional force is applied, the plates **734** and **736** continue to rotate and engage with one another. Further rotation of the plates **734** and **736** while being engaged may cause deformation of these plates. Such continued rotation and deformation may allow further movement of the arm **302** and the first panel **112** of the table **100** in synchrony with the rotation and deformation of the plates **734** and **736**. In some embodiments of the arrangement shown in FIG. **10**B, one or more of cams **310**, **318**, **332**, and **338** may be omitted because the first plate **734** effectively provides the function of such cams to allow rotation of the arms **302** and **304** for a period of time without deformation of the second plate **736**.

Referring to FIG. **10**C, in still another embodiment, the deformable member may include a first shaft **738** secured to the cam **310**, and a second shaft **740** secured to the edge **314**. The first shaft **738** terminates in a first plurality of gear teeth **742** and the second shaft **740** terminates in second plurality of gear teeth **744**. The first plurality of gear teeth **742** and the second plurality of gear teeth **744** are meshed with one another. When force is applied to the outside edge **124**, the first shaft **738** and the second shaft **740** move in synchrony with the cam **310** and one another. Additional force causes the gear teeth **742** and **744** to move against each other such that such gear teeth become deformed or may even become separated from the first and second shafts **738** and **740**. Such continued rotation of the shafts **738** and **740**, and deformation of the gear teeth **742** and **744** may allow further movement of the anti **302** and the first panel **112** of the table **100** in synchrony with such rotation and deformation. As noted above with respect to FIG. **10**B, the cams **310**, **318**, **332**, and **338** may be omitted from this embodiment also because the teeth **742** effectively provide the functionality of such cams.

In the foregoing, although reference is made only to the operation of the deformable member **308** with respect to FIGS. **10**A-**10**C, it should be apparent that any of the other deformable members **316**, **330**, and **334** of the workstation table **100** may be implemented as described above.

In some embodiments, a screw or pivot pin **342** may pivotally couple the first panel **112** and the second panel **114** of the workstation table **100** to one another.

When sufficient force is applied to either of the outside edges **124** or **134** of the workstation table **100**, the first arm **302** and the second arm **304** rotate about the torsion bars **308** and **330**, respectively, until the cams **310** and **332**, respectively, engage the stop **312**. Such rotation causes the first panel **112** and the second panel **114** to rotate about the pivot pin **342**. In some embodiments, the first arm **302** and the second arm **304** begin to rotate about the torsion bars **308** and **330** when a predetermined force is applied to either of the outside edges **124** or **134**. In some embodiments, such predetermined force may be approximately 700 pounds.

When the cams **310** and **322** engage the stop **312**, as shown in FIGS. **5**B and **6**B, further rotation of the first arm **302** and the second arm **304** about the torsion bars **308** and **330**, respectively, is prevented. If additional force is applied after engagement of the cams **310** and **322** with the stop **312**, the first panel **112** of the tabletop **102** rotates relative to the first arm **302** about the torsion bar **316**. Concurrently, because the pivot pin **342** couples the first panel **112** and the second panel **114**, the second panel **114** of the tabletop **102** rotates relative to the second arm **304** about the torsion bar **334**. The coupling of the first panel **112** and the second panel **114** by the pivot pin **342** causes both the first panel **112** and the second panel **114** to rotate in this manner when a force is applied to either of the outside edges **124** or **134**. Such rotation of the first panel **112** and the second panel **114** continues until the cams **318** and **338** engage the stops **320** and **340**, respectively, as shown in FIGS. **5**C and **6**C.

If still additional force is applied, the first panel **112** and the second panel **114** continue to rotate about the pivot pin **342**, as shown in FIGS. **5**D and **6**D. Such rotation may continue until maximum deformation of the table **100** is achieved. In some embodiments, such maximum deformation is achieved when the first panel **112** and the second panel **114** strike one another or the supports **106** and **108** sufficiently to stop the rotation. In some embodiments, the first panel **112** and second panel **114** are made of a material that deforms, partially or completely crushes, or breaks when the front edges **126** and **136**, or the rear edges **128** and **138**, strike one another. Such deformation or crushing may absorb additional force applied to the outside edges **124** or **134**.

Referring to FIG. **11**, in some embodiments, a shear pin **750** may also couple the first panel **112** and the second panel **114**. The shear pin **750** may prevent the first panel **112** and the second panel **114** from rotating about the pivot pin **342** until a force is applied to the outside edge **124** or **134** that is sufficient to deform or rupture the shear pin **750**.

In other embodiments, the front edges **126** and **136** may be chamfered so that the one edge, for example the edge **126**, nests inside the other, for example the edge **136**, when the workstation table is in a deformed configuration (as shown in FIGS. **5**D and **6**D). The rear edges **128** and **138** may be similarly chamfered so that one edge, for example the edge **128**, nests inside the other edge, for example the edge **138**.

In some embodiments, the length of the workstation table **100** between the supports **106** and **108** may span a distance that allows two or more individuals to be seated along each of the outside edges **124** and **134** of the workstation table **100**. In such embodiments, the workstation table **100** may absorb or resist at least approximately 4000 pounds of force applied to the outside edge **124** or **134** as the workstation table **100** deforms from the initial undeformed configuration shown in FIGS. **5**A and **6**A to the deformed configuration shown in FIGS. **5**D and **6**D.

In other embodiments, the length of the workstation table **100** may span a smaller distance that allows one individual to be seated along each of the outside edge **124** or **134** of the workstation table **100**. In such embodiments, the workstation table **100** may resist at least 2000 pounds of force applied to the outside edge **124** or **134** as the workstation table is deformed from the undeformed configuration shown in FIGS. **5**A and **6**A to the deformed configuration shown in FIGS. **5**D and **6**D.

In an accident, a passenger impacting an exemplary embodiment of the workstation table **100** may experience loads from 0 to 2100 pounds force as the workstation table **100** deforms from an undeformed configuration (FIG. **5**A) to the deformed configuration (FIG. **5**D).

In some embodiments, the cams **310** and **332**, and the stop **312** are disposed so that the torsion bars **308** and **330** rotate between approximately 3.5 degrees and 6.5 degrees from horizontal, and in some cases approximately 5 degrees, before the cams **310** and **312** engage the stop **312** (shown in FIGS. **5**B and **6**B). In such embodiments, the first panel **112** and the second panel **114** of the tabletop also rotate between approximately 3.5 degrees and 6.5 degrees from horizontal (i.e., the undeformed configuration). In other embodiments, the positions of the cams **310** and **332**, and the stop **312** may selected such that the cams **310** and **332** engage the stop **312**, after the torsion bars **310** and **330**, respectively, have rotated approximately 1 degree. In still other embodiments, the positions of such cams **310** and **332**, and the stop **312** may be selected to allow the torsion bars **310** and **330** to rotate between approximately 23.5 and approximately 26 degrees before the cams **310** and **332** engage the stop **330**. The particular rotation may be selected based on the environment in which the workstation table **100** is to be disposed and the forces such workstation table **100** is expected to encounter.

In some embodiments, the position of the cam **316** and the stop **320** on the arm **302** may be selected so that the cam **316** engages the stop **320** after the arm **302** has rotated between approximately 26.5 degrees and 29.5 degrees from horizontal. Similarly, the position of the cam **338** and the stop **340** on the arm **304** may be selected so that the cam **338** engages the stop **340** when the arm **304** has rotated approximately 26.5 degrees and 29.5 degrees from horizontal.

Referring to FIGS. **6**A-**6**D, in some embodiments, a portion of the first end of the first arm **302** may be configured with gear teeth **350** and a portion of the first end of the second arm **304** may also be configured with gear teeth **352**. The first and second arms **302** and **304** may be disposed on the plate **300** so that the gear teeth **350** mesh with the gear teeth **352**. Such meshing of the gear teeth **350** and **352** facilitate synchronization of movement of the first arm **302** with movement of the second arm **304**, and hence, cause the first panel **112** of the workstation table **100** to move in synchrony with the second panel **114**.

The deforming mechanism **118** may be substantially identical to the deforming mechanism **120** described above.

In one example embodiment of the workstation table **100**, when the workstation table is in the undeformed configuration, the horizontal distance between the front edge **126** and the rear edge **128** may be approximately 44 inches. The horizontal distance between the outside edge **124** and the outside edge **134** may be approximately 28.125 inches. The horizontal distance between the center of the pivot pin **342** about which the first panel **112** and the second panel **114** pivot and the center of the torsion bar **316** about which the arm **302** rotates may be approximately 6.125 inches. A horizontal distance between the pivot pin **342** and the center of the torsion bar **308** about which the arm **302** also rotates may be approximately 1.5 inches. The vertical distance between the center of the pivot pin **342** and the center of the torsion bar **316** may be approximately 0.56 inches. The vertical distance between the center of the pivot pin **342** and the center of the torsion bar **316** may be approximately 1.03 inches. The horizontal and vertical distances between the center of the pivot pin **342** and the center of the torsion bar **330** may be identical to the horizontal and vertical distances between such screw and the center of the torsion bar **308**. Similarly, the horizontal and vertical distances between the center of the pivot pin **342** and the center of the torsion bar **338** may be identical to the horizontal and vertical distances between the center of such screw and the torsion bar **316**.

Once the workstation table **100** has been deformed to any degree, friction between the components thereof continues to hold the workstation table **100** in such deformed configuration. However, such friction may be overcome by applying a force on the tabletop **102**, which causes the workstation **100** to return to the undeformed configuration. If the workstation table **100** is disposed adjacent a sidewall of a transit car that includes a window, the return of the workstation table **100** into such undeformed configuration may provide sufficient clearance for emergency personnel to enter the transit car through such window. In one example embodiment, the each torsion bar **308**, **316**, **330**, and **338** is manufactured from a plastically deforming material. Once torque has been applied to the torsion bar **308**, **316**, **330**, or **338** to rotate such torsion bar, for example, when the workstation table **100** deforms, such torsion bar remains rotated (or torqued) even if the workstation table **100** is returned to the undeformed configuration.

FIGS. **7A-7D** show the workstation table **100** starting in a deformed configuration (FIG. **7A**), before progressively returning to an undeformed position (FIGS. **7B** and **7C**), until the workstation table returns to the completely undeformed configuration (FIG. **7D**). Because the cam **318** is fixedly attached to the torsion bar **316**, neither the torsion bar **316** nor the cam **318** rotates as the workstation table **100** is returned to the undeformed configuration (FIG. **7D**) from the deformed configuration (FIG. **7A**). Similarly, none of the other torsion bars **316**, **330**, and **334** and respective cams **318**, **330**, and **338** fixedly secured thereto rotate as the workstation table **100** returned to the undeformed configuration (FIG. **7D**). As a result, an angle **700** spanned by an edge **702** of the cam **318** and an edge **704** of the first panel **112** to which the torsion bar **316** is secured remains substantially constant as the workstation tables moves from the deformed configuration (FIG. **7A**) to the undeformed configuration (FIG. **7D**). Similarly, an angle **706** spanned by an edge **708** of the cam **310** and an edge **710** of the arm **302** remains substantially constant as the table is returned from the deformed configuration (FIG. **7A**) to the undeformed configuration (FIG. **7D**). Similarly, angles between the cams **330** and **338** and the edges of the second panel **114** and the arm **304** remain substantially constant as the table moves through the configurations illustrated in FIGS. **7A-7D**.

Referring to FIG. **8**, the stop **310** of FIGS. **5A-5D** may be a structural component that extends the length of the workstation table and to which the table supports **104** and **106** may be attached. In some embodiments, the deforming mechanisms **118** and **120** may also be attached to such structural component.

FIG. **9** shows a graph of the horizontal displacement of the outside edge **124** or **134** versus force absorbed by an exemplary embodiment of the workstation table **100** at such displacement, as the table deforms from the configuration shown in FIG. **5A** through the configuration shown in FIG. **5B**. The labels **5A-5D** shown in such graph correspond to the configurations of the table shown in respective FIGS. **5A-5D**. The label associated with **5D** in the graph corresponds to a situation when all of the cams have been engaged, and the table may still continue to compress until the edges crush or nest as described above.

The components of the workstation table **100** described above may be manufactured from steel, stainless steel, aluminum, plastics, fiber reinforced plastics, composites, high pressure laminates, and the like. The torsion bars described above may be manufactured from steel, stainless steel, or other materials that will be apparent to those having skill in the art.

The energy absorption characteristics of the workstation table **100** may be customized by modifying the lengths of one or both of the arms **302** and **304**; modifying how much one or both of the cams **318** and **338** may rotate before engaging the stops **320** and **340**, respectively; modifying how much one or both of the cams **310** and **332** may rotate before engaging the stop **312**; modifying the materials that comprise the torsion bars **308**, **316**, **330**, and **334**; modifying the angle spanned by the arms **302** and **304** when the table **100** is in the initial undeformed configuration; modifying the distance between the pivot pin **342** and where the arms **302** and **304** are secured to the first panel **112** and the second panel **114**, respectively; and/or modifying the diameters of the torsion bars **308**, **316**, **330**, and **334**. The energy absorption characteristics of the workstation table **100** may be further customized by trimming the outside edges **124** and **134** with an energy absorbent or cushioned material such as a metal honeycomb, or a crushable material such as a foam, for example, Styrofoam.

For example, increasing the length of the arms **302** and **304** may result in a corresponding increase in the amount of energy the workstation table **100** may absorb. The length of the arms **302** and **304** may also so be selected in accordance with a desired height of the workstation table **100** when such table is in the fully deformed configuration.

Similarly, increasing how much the cam **310** may rotate before engaging the stop **312** may determine how much the workstation table **100** deforms in response different amounts of forces applied thereto, because such rotation may affect the amount of energy that is absorbed by the deformation of the torsion bar **308** relative to the amount of energy that is absorbed by the deformation of the torsion bar **316**.

As apparent to one who has skill in the art, amount of energy absorbed by the workstation table **100** due to the deformation of the torsion bars **308**, **316**, **330**, and **334** depends on the amount of torque (toque to yield) required to achieve a plastic deformation, yielding, or a permanent change in the shape of the torsion bars **308**, **316**, **330**, and **334**. The torque to yield (T) of the torsion bar **308**, **316**, **330**, or **334** depends on the diameter (D) of the torsion bar **308**, **316**, **330**, or **334**, and the torsional yield strength (c) of the material that comprises such torsion bar **308**, **316**, **330**, or **334**. The value of the torque to yield (T) may be calculated from the torsional yield strength (T) and the diameter as follows:

$$T=(\tau^*\pi D^3)/16$$

For example, if the 1018 steel has a torsional yield strength of 30,609 psi. Accordingly, the following table shows torque to yield of a torsion bar made from 1018 steel and having various diameters:

Diameter (in)	Torque to Yield (in-lb)
0.063	2
0.125	12
0.188	40
0.25	94
0.375	317
0.5	751
0.75	2535
1	6010

In an exemplary workstation table **100**, the outside edges **124** and **134** are between approximately 15 and approximately 36 inches long; front edges **126** and **136** and rear edges **128** and **138** that are between approximately 20 and approximately 56 inches long. Each arm **314** and **336** of such table is between approximately 7.5 and approximately 18 inches long. The distance between the torsion bars **308** and **316**, and between the torsion bars **330** and **334**, may be between approximately 3 and 10 inches. The torsion bars **308**, **316**, **330**, and **334** may be cylindrical and each may have a diameter of less than approximately one inch, and in some cases between approximately 0.2 inches and approximately 0.4 inches. In one embodiment, the torsion bars **308** and **330** have a diameter of approximately 0.25 inches, and the torsion bars **316** and **338** have a diameter of approximately 0.3125 inches. In some embodiments, if the torsion bars are manufactured from 1018 steel, the workstation table will absorb resist with between 10 pounds and 1200 pounds of force when the workstation table begins to deform (i.e., the torsion bars **316** and **334** begin to deform), between 100 and 4500 pounds of force when the cam **318** engages the cam **320**, and between 100 and 4500 pounds of force to deform the table to fully deformed configuration.

In some embodiments the workstation table **100** may include a top layer **354** that is affixed to the first and second panels **112** and **114**. Such top layer **354** may be affixed so that the top layer **354** does not separate from the first and second panels **112** and **114** when the workstation table **100** deforms. In some embodiments, the top layer **354** may crack or otherwise become damaged, but pieces of the top layer **354** do not separate from the panels **112** and **114** and create a projectile hazard. In some embodiments, the top layer **354** is manufactured from an acrylic, a metal, vinyl, melamine, and the like. The top layer **354** may be affixed to the first and second panels **112** and **114** using, for example, an adhesive. In one embodiment, the adhesive is uniformly applied between the top layer **354** and the panels **112** and **114**, so that substantially of the top layer **354** is bonded to the panels **112** and **114**.

Referring to FIGS. **12** and **13**, in some embodiments, the tabletop **102** may comprise a frame **800** and a top member **802** secured to the frame **800**. In some embodiments, the top member **802** may be may manufactured from a honeycomb metal, a laminate, and the like, to which the top layer **354** is affixed, for example, by an adhesive. In other embodiments, the top layer **354** may be integral with the top member **802**. The top member **802** may include the first panel **112** and the second panel **114** separated by a bendable portion **804**. In some embodiments, the first panel **112** and the second panel **114** are an integral unit and comprise a single sheet. In other embodiments, the first panel **112** and the second panel **114** comprise separate sheets of material. In some embodiments, the bendable portion **804** couples the first panel **112** and the second panel **114**. When force is applied to the workstation table **100** the first panel **112** and the second panel **114** rotate relative to the bendable portion **804**.

In some embodiments, the frame **800** includes a first frame portion **810** and a second frame portion **812**. The first frame portion **810** and the second frame portion **812** may be pivotally coupled to one another by the pivot pin **342**, and optionally the shear pin **750**. The deforming mechanisms **118** and **120** are secured the first frame portion **810** and the second frame portion **812**. Specifically, the deforming members **308**, **316**, **330**, and **334** are secured to the edges of the corresponding first frame portion **810** and the second frame portion **812** as described above.

In some embodiments, the table member **802** is secured to the frames by screws (not shown), an adhesive, welding, and the like.

An embodiment of the workstation table **100** when installed in a transit car may at least meet one or more of the following safety criteria with respect to an anthropomorphic test device that has an interaction with such table **100** during a crash test per rail standards:

Remain attached during testing;

A head injury criteria (HIC) that does not exceed 700;

A neck injury criteria (Nij) that does not exceed 1.0;

Neck axial tension of less than 938 lbf (4000 N);

Chest deceleration of less than 60 G over a 3 ms clip;

Chest compression (the distance the sternum may be pressed) of less than 2.5 inches (63 mm);

Chest viscous criterion that measures internal damage to the chest area less than 1.0 m/s;

Abdominal compression less than 2.6 inches (67 mm);

Abdominal viscous criterion less than 1.98 m/s; and

Axial femur loads less than 2250 lbf (10,000 N).

In addition, during quasi-static testing as is known to those having skill in the art, an embodiment workstation table **100** will also meet one or more of the following criteria:

Remain attached during testing;

Absorb 6,250 in-lb of energy for each passenger that may impact it; and

Force remains less than 2,250 lbf per passenger.

The above criteria refer to test measurements and computations that have been defined by industry organizations, for example, the American Public Transportation Association (APTA), or that are apparent to those having skill in the art.

The workstation table **100** and the five point deforming mechanisms **118** and **120** described above is simple and adaptable to different applications. The geometry of such deforming mechanism **118** and **120** including distances between the pivot pin **342** and the various torsion bars **308**, **316**, **330**, and **334**, and rotations undertaken by the various cams **310**, **318**, **332**, and **338** may be modified. Such modifications may be made to achieve desired outcomes in terms of packaging such workstation table **100** and deforming mechanisms **118** and **120**, and also to achieve desired outcomes in an interaction between a passenger and the workstation table **100** in the event of an accident. Such modifications to the geometry and/or torque loads of such torsion bars will be apparent to those who have skill in the art. For example, in some embodiments, some or all of the torsion bars **308**, **316**, **330**, and **334** may be modified to be simple pins that are used as pivots, and which do not provide resistance. Such a modification may be made to reduce the load or change the forces absorbed by the workstation table at certain displacements.

INDUSTRIAL APPLICABILITY

All references, including publications, patent applications, and patents, cited herein are hereby incorporated by reference to the same extent as if each reference were individually and specifically indicated to be incorporated by reference and were set forth in its entirety herein.

The use of the terms "a" and "an" and "the" and similar references in the context of describing the disclosure (especially in the context of the following claims) are to be construed to cover both the singular and the plural, unless otherwise indicated herein or clearly contradicted by context. Recitation of ranges of values herein are merely intended to serve as a shorthand method of referring individually to each separate value falling within the range, unless otherwise indicated herein, and each separate value is incorporated into the specification as if it were individually recited herein. All methods described herein can be performed in any suitable order unless otherwise indicated herein or otherwise clearly contradicted by context. The use of any and all examples, or exemplary language (e.g., "such as") provided herein, is intended merely to better illuminate the disclosure and does not pose a limitation on the scope of the disclosure unless otherwise claimed. No language in the specification should be construed as indicating any non-claimed element as essential to the practice of the disclosure.

Numerous modifications to the present disclosure will be apparent to those skilled in the art in view of the foregoing description. Preferred embodiments of this disclosure are described herein, including the best mode known to the inventors for carrying out the disclosure. It should be understood that the illustrated embodiments are exemplary only, and should not be taken as limiting the scope of the disclosure.

What is claimed is:

1. An energy absorbing table, wherein the table deforms in response to application of a force thereto, comprising:

a support member;

a first panel;

a first arm, the first arm coupled to the support member by a first deformable member and to the first panel by a second deformable member;

a first cam and a first stop associated with the first deformable member; and

wherein application of force to the first panel causes the first arm to move in synchrony with the first deformable member and the second deformable member, the first deformable member rotates with the first cam until the first cam engages the first stop, and wherein application of force to the first panel after engagement of the first cam and the first stop, causes the first deformable member permanently deform, and the first arm to move in synchrony with deformation of the first deformable member.

2. The energy absorbing table of claim **1**, further comprising a second panel, a second arm coupled to the second panel, a third deformable member that couples the second panel to the support member, wherein when the force is applied to one of the first and the second panel, the second arm moves in synchrony with the third deformable member.

3. The energy absorbing table of claim **2**, further comprising a second cam and a second stop associated with the third deformable member, wherein when the force is applied to one of the first panel and the second panel, the third deformable member rotates with the second cam until the second cam engages the second stop, and application of force after engagement of the second cam with the second stop causes the third deformable member to deform.

4. The energy absorbing table of claim **2**, wherein the first arm comprises a first end proximate the first deformable member, and the second arm comprises a second end proximate the third deformable member, wherein the first end and the second end each comprise gear teeth, and the gear teeth at the first end mesh with the gear teeth at the second end.

5. The energy absorbing table of claim **2**, wherein the first panel and the second panel are an integral unit and the first panel and the second panel move in synchrony with one another.

6. The energy absorbing table of claim **2**, wherein the deformable members are one of torsion bars, torsion springs, cantilevered beams, cantilevered panels and gear teeth.

7. The energy absorbing table of claim **6**, wherein the deformable members are steel bars and have a diameter of less than or equal to approximately one inch.

8. The energy absorbing table of claim **2**, further comprising a shear pin, wherein the first panel and the second panel are coupled to one other by the shear pin, wherein rotation of one of the first panel and the second panel causes the shear pin to deform or rupture.

9. The energy absorbing table of claim **1**, wherein the support member is secured to at least one of a sidewall and a floor of a transit car, and the support member remains secured to the at least one of the sidewall and the floor of the transit car when the first panel rotates.

10. An energy absorbing table, wherein the table deforms in response to application of energy thereto, comprising:

a support member;

a first panel;

an arm, the arm coupled to the support member by a first deformable member;

a first cam and a first stop associated with the first deformable member; and

wherein when a force is applied to the first panel, the arm moves in synchrony with both the first deformable member and the first cam until the first cam engages the first stop, the arm moves in synchrony with deformation of the first deformable member after the first cam engages the first stop, and the amount of force necessary to cause permanent deformation of the deformation member and the arm to move after the first cam engages the first stop is determined by a characteristic of the first deformable member.

11. The energy absorbing table of claim **10**, wherein the characteristic is a diameter of the first deformable member, and the diameter is less than approximately one inch.

12. The energy absorbing table of claim **10**, wherein the characteristic is a material from which the deformable member is manufactured.

13. The energy absorbing table of claim **12**, wherein the material comprises at least one of 1018 steel, stainless steel, a low carbon steel, a metal, and a metal alloy.

14. The energy absorbing table of claim **10**, wherein the first deformable member is one of a torsion bar, torsion spring, cantilevered beam, a cantilevered panel, and a gear tooth.

15. The energy absorbing table of claim **10**, wherein rotation of the arm causes the first panel to rotate about the first deformable member.

16. The energy absorbing table of claim **10**, wherein the arm is coupled to the first panel by a second deformable member, and the first panel rotates in synchrony with deformation of the second deformable member.

17. The energy absorbing table of claim **10**, wherein the first panel includes an outside edge, wherein the outside edge moves towards the support member as the first panel rotates.

18. The energy absorbing of claim **10**, including a second panel and a top layer, wherein the second panel is disposed adjacent the first panel and the top layer is affixed to at least a portion of a top of the first panel and a portion of a top of the second panel, wherein the second panel moves in synchrony with the first panel and the top layer remains secured to the first and second panels when the first and second panels move.

19. The energy absorbing table of claim **10**, wherein the support member is secured to at least one of a sidewall and a floor of a transit car, and the support member remains secured to the at least one of the sidewall and the floor of the transit car when the first arm moves.

20. The energy absorbing table of claim **19**, wherein the deformable table is disposed between facing seats.

21. A workstation table, comprising:

a first panel, the first panel having a first top surface and a first outer edge;

a second panel, the second panel having a second top surface and a second outer edge;

a support member;

a first deforming mechanism coupled to the first panel and the support member, and comprising a first permanently deformable member; and

wherein when a force is applied to the first outer edge, the first deforming mechanism causes permanent deformation of the first permanently deformable member, and causes the first panel to move from a first configuration in which the a first top surface and the second top surface occupy substantially parallel planes to a second configuration in which the first top surface and the second top surface do not occupy substantially parallel planes.

22. The workstation table of claim **21**, wherein the support member is secured to at least one of a floor or a sidewall of a transit vehicle, and the support member remains secured to the at least one of the floor or the sidewall as the first panel moves from the first configuration to the second configuration.

23. The workstation table of claim **22**, wherein the force results from a body colliding with the table due to a deceleration of the transit vehicle.

24. The workstation table of claim **21**, wherein when the first panel is in the second configuration the first top surface and the second top surface span an acute interior angle between approximately 35 and 43 degrees.

25. The workstation table of claim **21**, further comprising a second deforming mechanism that moves the second panel in synchrony with the first panel, and wherein the first deforming mechanism comprises an arm, a first cam, and a first stop, wherein the first permanently deformable member is coupled to the arm and the support member, and when the force is applied to the first edge, the arm, the cam, and the first permanently deformable member move an axis of the first permanently deformable member until the cam engages the stop.

26. The workstation table of claim **25**, wherein the cam rotates in synchrony with the first permanently deformable member.

27. The workstation table of claim **25**, wherein applying additional force causes the first panel to move in synchrony with deformation of the first permanently deformable member.

28. The workstation table of claim **27**, wherein the first outer edge moves closer to the second outer edge as the arm pivots.

29. The workstation table of claim **27**, wherein the first and the second permanently deformable members are permanently deformed when the first panel is moved from the first configuration to the second configuration.

30. The workstation table of claim **21**, wherein the first outer edge is substantially parallel to the second outer edge.

31. The workstation table of claim **21**, wherein the first panel includes a first inner edge and a first front edge, and the second panel includes a second inner edge and a second front edge, wherein the first inner edge is substantially parallel to the second inner edge, and the first panel and the second panel are disposed so that the first inner edge is proximate the second inner edge.

32. The workstation table of claim **31**, wherein the first panel includes a first side edge and the second panel includes a second side edge, wherein when the first panel is moved into the second configuration, a portion of the first side edge proximate the first inner edge nests inside the second side edge proximate the second inner edge.

33. The workstation table of claim **31**, further comprising a pin that secures the first front edge with the second front edge, and one of the first side edge and the second side edge is chamfered.

34. The workstation table of claim **31**, wherein applying a downward force on the first panel adjacent the first inner edge causes the first panel to move from the second configuration to the first configuration.

35. The workstation table of claim **21**, wherein the first permanently deformable member is a torsion bar.

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